

## Parasitological survey of some important fish species of Lake Balaton

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**Abstract:** In the framework of a one-year survey, the parasitic infections of 299 specimens of the 15 economically and faunistically most important fish species of Lake Balaton were monitored. Seventy-one parasites species were identified to the species and 17 to the genus, and the data obtained on the parasites are reported. In Lake Balaton, the introduced eel parasite *Anguillicola crassus* can be considered the most prevalent parasite species. Besides the definitive host, it could be detected in several fish species acting as paratenic hosts. Occasionally a rather intensive *Ergasilus sieboldi* infection occurred on the pike-perch: both the gills and the operculum of the fish were covered by large masses of these crustaceans. *Ichthyocotylurus* metacercariae adhering to the pericardium of the pike-perch and the specimens of *Tracheliastes maculatus* colonising the body surface of the bream in the spring months seem to have pathological significance. Of the parasites found, *Hoferellus carassii*, *Spironucleus elegans*, *Paradilepis scolecina* and *Orientocreadium siluri* are now reported from Lake Balaton for the first time.

**Key words:** Protozoa (Mastigophora, Apicomplexa, Myxozoa, Ciliophora), Platyhelminthes (Monogenea, Cestoda, Aspidogastrea, Trematoda), Nematelminthes (Nematoda), Annelida (Hirudinea), Mollusca (Bivalvia), Arthropoda (Crustacea), hosts: *Stizostedion lucioperca*, *S. volgensis*, *Anguilla anguilla*, *Abramis brama*, *Carassius auratus gibelio*, *Neogobius fluviatilis*, *Gymnocephalus cernuus*, *Silurus glanis*, *Pelecus cultratus*, *Blicca bjoerkna*, *Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Tinca tinca*, *Aspius aspius*, seasonal changes, parasite fauna, Lake Balaton

### INTRODUCTION

Lake Balaton is the lake of the biggest water surface in Central Europe. It is important for Hungary as a site of both recreation and fishing.

Because of its shallow water, Lake Balaton is extremely sensitive to environmental effects. Therefore, factors influencing the biological balance of the lake very often give rise to fish mortality. Although the parasite fauna of Lake Balaton fishes is relatively well studied, the fish mortalities observed in recent years call for more thorough investigations.

The earliest studies were carried out by Rátz (1897) who reported the occurrence of some protozoan, metazoan and crustacean parasites in the lake. Subsequently, data on the occurrence of parasites were contained in the works of Jaczó (1940, 1941, 1949), who also described some new myxosporean species from fishes. Systematic studies on the parasite fauna of Lake Balaton were performed by Molnár (1962, 1964, 1966a, b, 1968, 1969, 1970a, b) who provided data primarily on the occurrence of helminth parasites. Of the other authors, Geyer (1939a, b) and Ponyi and Molnár (1969) reported on the crustacean parasites occurring on Lake Balaton fishes. Faunistic studies have been conducted by Matskási (1967, 1968), Matskási et al. (1971), and Mészáros (1967, 1968). Mödler (1934) reported the frequent incidence of *Apophallus donicus* while Molnár et al. (1968) that of *Ligula intestinalis*. Relatively little is known about the protozoan infections of Lake Balaton fishes. Although the occurrence of some species has been described by Molnár (1970a, b), instead of conducting a systematic faunistic survey only the development of some species has been studied and some new species have been demonstrated (Molnár 1988, 1989).

A new survey of the parasite fauna was called for by the massive eel mortality that occurred in Lake Balaton in 1991–1992, which Molnár et al. (1991, 1993) attributed to the swimbladder injury caused by the introduced eel nematode *Anguillicola crassus*.

Of the fish species living in Lake Balaton, the pike-perch, which is the "heraldic fish" of the lake, and the introduced eel have outstanding economic importance. Other fish species whose health status can affect the biological balance of the lake include the bream (which accounts for 80% of the fishermen's catch), the ruffe and bleak serving as pike-perch food, and the river goby and gibel carp which are new arrivals (Bíró 1995).

The aim of this work was to detect the parasites of these fish species and to collect data on their seasonal occurrence.

## MATERIALS AND METHODS

The studies were conducted in 1994, in the fishing season which lasted from 16 April to 9 November. On a total of 12 occasions, 299 fish belonging to 15 different species were collected at several sampling sites of the lake (Alsóörs, Sóstó, Csopak, Tihany, Szemes, Keszthely) and subjected to complete parasitological examination. Of the species included in our test protocol higher numbers of fish were dissected: thus, the results contain parasitological data of 55 pike-perch (*Stizostedion lucioperca*), 29 Volga pike-perch (*Stizostedion volgensse*), 82 eels (*Anguilla anguilla*), 60 breams (*Abramis brama*), 18 gibel carp (*Carassius auratus gibelio*) and 27 river gobies (*Neogobius fluviatilis*). The distribution and numbers of the fish species of which only a few specimens were examined were as follow: sheatfish (*Silurus glanis*) 4, ruffe (*Gymnocephalus cernuus*) 4, knife (*Pelecus cultratus*) 3, white bream (*Blicca bjoerkna*) 7, common carp (*Cyprinus carpio*) 4, grasscarp (*Ctenopharyngodon idella*) 1, silver carp (*Hypophthalmichthys molitrix*) 2, tench (*Tinca tinca*) 2, and asp (*Aspius aspius*) 1. The body length of the fish species studied was not uniform (it ranged between 10 and 75 cm). The fish derived from the fishermen's catch included bigger specimens while those caught with a small net were of smaller size, due to the use of nets of different mesh sizes. The species distribution of the fish studied at the individual sampling times was unfortunately not uniform, as it depended on the catch.

Most of the fish were caught from the basin of the lake with the help of the research boat of the Limnological Research Institute of the Hungarian Academy of Sciences and of

fishermen from the Balaton Fisheries Co. Ltd. In some instances, we caught fish in the littoral zone with our own 20-metre trawl-net. In each case, the fish were transported to the laboratory alive, in aerated cans or nylon bags inflated with oxygen. When samples were taken in the summer, the water used for transportation was cooled with ice. After arrival at our institute, the fish were placed into concrete basins with flow-through water or in large plastics tanks with air insufflation, and were then dissected within the shortest time possible (within a few days). As far as possible, all inner organs (liver, kidney, heart, intestines, swimbladder, gallbladder), the gill filaments, the eyes, the fins and the skin were examined during dissection. The examinations included dissections under stereomicroscope, a light-microscopic protozoological examination, and a histological processing of the most interesting cases. The taxonomical classification of the demonstrated parasites was done on the basis of Lom and Dykova's manual (1992) and, for the metazoans, the parasite identification handbook edited by Bauer (1985, 1987).

## RESULTS

The taxonomical position and species composition of the parasites recorded during the dissections are shown in parasite-host list. Data on the occurrence of parasites by fish species and depending on the season are contained in Tables 1-7.

### Parasite-host relationships

#### PROTOZOA

##### Mastigophora

##### Kinetoplastidea

#### TRYPANOSOMATIDAE

*Trypanosoma danilewskyi* Laveran et Mesnil, 1904 — *Abramis brama*

##### Diplomonadea

#### HEXAMITIDAE

*Spiromucleus elegans* Lavier, 1936 — *Carassius auratus gibelio*

##### Apicomplexa

##### Coccidia

#### EIMERIIDAE

*Eimeria anguillae* Léger et Hollande, 1922 — *Anguilla anguilla*

*Eimeria rutili* Dogiel et Bychovsky, 1938 — *Abramis brama*

*Goussia acerinae* (Pellérdy et Molnár, 1971) — *Gymnocephalus cernuus*

*Goussia carpelli* (Léger et Stankovitch, 1921) — *Cyprinus carpio*, *Carassius auratus gibelio*

*Goussia pannonica* Molnár, 1989 — *Abramis brama*

*Goussia leucisci* (Schulman et Zaika, 1964) — *Abramis brama*, *Carassius auratus gibelio*

*Goussia stankovitchi* (Stankovitch, 1920) — *Abramis brama*

*Goussia sinensis* (Chen, 1956) — *Hypophthalmichthys molitrix*

*Goussia* sp. I. — *Stizostedion volgense*

*Goussia* sp. II. — *Stizostedion volgense*

*Goussia* sp. III. — *Neogobius fluviatilis*

## Myxozoa

## Myxosporea

## SPHAEROSPORIDAE

- Sphaerospora danubialis* Molnár, 1991 — *Stizostedion lucioperca*, *Stizostedion volgensse*  
*Sphaerospora* spp. — *Pelecus cultratus*, *Abramis brama*  
*Myxobilatus legeri* (Cépede, 1905) — *Abramis brama*, *Aspius aspius*, *Pelecus cultratus*  
*Hoferellus carassii* Achmerov, 1960 — *Carassius auratus gibelio*  
*Chloromyxum* sp. — *Abramis brama*  
*Myxidium rhodei* Léger, 1905 — *Abramis brama*  
*Myxidium giardi* Cépede, 1906 — *Anguilla anguilla*  
*Myxidium* spp. — *Aspius aspius*, *Abramis brama*, *Pelecus cultratus*, *Hypophthalmichthys molitrix*

## MYXOBOLIDAE

- Myxobolus bramae* Reuss, 1906 — *Abramis brama*  
*Myxobolus cyprini* Doflein, 1898 — *Cyprinus carpio*  
*Myxobolus pseudodispar* Gorbunova, 1936 — *Abramis brama*  
*Myxobolus portucalensis* Saraiva et Molnár, 1990 — *Anguilla anguilla*  
*Myxobolus* spp. — *Stizostedion lucioperca*, *Stizostedion volgensse*, *Abramis brama*, *Blicca bjoerkna*  
*Henneguya creplini* (Gurley, 1894) — *Stizostedion lucioperca*

## Ciliophora

## Kinetophragminophorea

## TRICHOPHRYIDAE

- Capriniana piscium* (Bütschli, 1889) — *Stizostedion lucioperca*

## Oligohymenophorea

## ICHTHYOPHTHIRIIDAE

- Ichthyophthirius multifiliis* Fouquet, 1876 — *Stizostedion lucioperca*, *Abramis brama*

## TRICHODINIDAE

- Trichodina* sp. — *Stizostedion lucioperca*  
*Trichodinella* sp. — *Stizostedion lucioperca*

## EPISTYLIDIDAE

- Apiosoma* spp. — *Stizostedion lucioperca*, *Gymnocephalus cernuus*

## Miscellaneous organisms:

- Dermocystidium percae* Reichenbach-Klinke, 1950 — *Stizostedion lucioperca*

## Metazoa

## Platyhelminthes

## Monogenea

## DACTYLOGYRIDAE

- Dactylogyrus auriculatus* (Nordmann, 1832) — *Abramis brama*  
*Dactylogyrus falcatus* (Wedl, 1857) — *Abramis brama*  
*Dactylogyrus wunderi* Bychowsky, 1931 — *Abramis brama*  
*Dactylogyrus zandti* Bychowsky, 1933 — *Abramis brama*  
*Dactylogyrus amphibothrium* Wagener, 1857 — *Gymnocephalus cernuus*  
*Dactylogyrus hemiamphibothrium* Ergens, 1956 — *Gymnocephalus cernuus*

*Dactylogyrus extensus* Mueller et van Cleave, 1932 — *Cyprinus carpio*

*Pseudodactylogyrus bini* (Kikuchi, 1929) — *Anguilla anguilla*

*Pseudodactylogyrus anguillae* (Yin et Sproston, 1948) — *A. anguilla*

*Ancyrocephalus paradoxus* Creplin, 1839 — *Stizostedion lucioperca*, *Stizostedion volgense*

#### GYRODACTYLIDAE

*Gyrodactylus luciopercae* Gussev, 1962 — *Stizostedion lucioperca*, *Stizostedion volgense*

*Gyrodactylus* spp. — *Neogobius fluviatilis*, *Gymnocephalus cernuus*

#### DIPLOZOIDAE

*Diplozoon paradoxum* Nordmann, 1932 — *Abramis brama*

*Paradiplozoon pavlovskii* (Bychowsky et Nagibina, 1959) — *Aspius aspius*

#### Cestoda

#### CARYOPHYLLIDAE

*Caryophyllaeus laticeps* (Pallas, 1781) — *Abramis brama*

*Caryophyllaeus fimbriceps* Annenkova-Chlopina, 1919 — *Cyprinus carpio*

#### TRIAENOPHORIDAE

*Trienophorus nodulosus* (Pallas, 1781) (l.) — *Stizostedion lucioperca*

#### LIGULIDAE

*Ligula intestinalis* (Linnaeus, 1758) (l.) — *Abramis brama*

*Ligula* sp. (l.) — *Neogobius fluviatilis*

#### BOTHRIOCEPHALIDAE

*Bothriocephalus claviceps* (Goeze, 1782) — *Anguilla anguilla*

#### PROTEOCEPHALIDAE

*Proteocephalus cernuae* (Gmelin, 1790) — *Gymnocephalus cernuus*

*Proteocephalus percae* (Müller, 1780) — *Stizostedion lucioperca*, *Stizostedion volgense*

*Proteocephalus macrocephalus* (Creplin, 1825) — *Anguilla anguilla*

*Proteocephalus osculatus* (Goeze, 1782) — *Silurus glanis*

*Proteocephalus torulosus* (Batsch, 1786) — *Aspius aspius*

*Proteocephalus* sp. — *Neogobius fluviatilis*

#### DILEPIDIDAE

*Paradilepis scolecina* (Rudolphi 1919) (l.) — *Abramis brama*, *Carassius auratus gibelio*

#### Aspidogastrea

#### ASPIDOGASTRIDAE

*Aspidogaster limacoides* Diesing, 1895 — *Cyprinus carpio*

#### Trematoda

#### BUCEPHALIDAE

*Bucephalus polymorphus* Baer, 1827 — *Stizostedion lucioperca*, *Stizostedion volgense*

*Bucephalus polymorphus* (l.) — *Stizostedion lucioperca*, *Stizostedion volgense*

*Rhipidocotyle illense* (Ziegler, 1883) — *Stizostedion lucioperca*, *Stizostedion volgense*

*Rhipidocotyle illense* (l.) — *Abramis brama*, *Stizostedion lucioperca*, *Stizostedion volgense*

#### SANGUINICOLIDAE

*Sanguinicola inermis* Plehn, 1905 (l.) — *Cyprinus carpio*, *Carassius auratus gibelio*

*Sanguinicola* sp. (l.) — *Abramis brama*

## MONORCHIDAE

*Asymphyiodora immitans* (Mühling, 1898) — *Abramis brama*, *Blicca bjoerkna*  
*Asymphyiodora tincae* (Modeer, 1790) — *Tinca tinca*

## OPECOELIDAE

*Nicolla skrjabini* (Iwanitzky 1928) — *Stizostedion lucioperca*, *Stizostedion volgense*,  
*Gymnocephalus cernuus*, *Pelecus cultratus*

## ORIENTOCREADIIDAE

*Orientocreadium siluri* (Bychowsky et Dubinina, 1954) — *Silurus glanis*

## HETEROPHYIDAE

*Apophallus muehlingi* (Jägerskiöld 1898) (l.) — *Stizostedion lucioperca*, *Abramis brama*,  
*Carassius auratus gibelio*

## DIPLOSTOMIDAE

*Diplostomum spathaceum* (Rudolphi, 1819) (l.) — *Stizostedion lucioperca*, *Abramis brama*,  
*Carassius auratus gibelio*, *Ctenopharyngodon idella*, *Silurus glanis*, *Hypophthalmichthys molitrix*  
*Tylodelphis clavata* (Nordmann, 1832) — *Stizostedion volgense*

## STRIGEIDAE

*Ichthyocotylurus* spp. — *Stizostedion lucioperca*, *Stizostedion volgense*, *Abramis brama*,  
*Gymnocephalus cernuus*, *Blicca bjoerkna*

## Nemathelminthes

## Nematoda

## CAMALLANIDAE

*Camallanus truncatus* (Rudolphi, 1814) — *Stizostedion lucioperca*, *Stizostedion volgense*,  
*Gymnocephalus cernuus*

## PHILOMETRIDAE

*Philometra ovata* (Zeder, 1803) — *Abramis brama*  
*Philometra kotlani* (Molnár, 1969) — *Aspius aspius*  
*Philometroides sanguinea* (Rudolphi, 1819) — *Carassius auratus gibelio*

## DRACUNCULIDAE

*Anguillicola crassus* Kuwahara, Niimi et Itagaki, 1974 — *Anguilla anguilla*  
*Anguillicola crassus* (l.) — *Neogobius fluviatilis*, *Pelecus cultratus*, *Gymnocephalus cernuus*,  
*Silurus glanis*

## DANICONEMATIDAE

*Daniconema anguillae* Moravec et Koie, 1897 — *Anguilla anguilla*  
*Daniconema anguillae* (l.) — *Anguilla anguilla*

## ANISAKIDAE

*Contracoecum* sp. (l.) — *Abramis brama*  
*Raphidascaris acus* (Bloch, 1779) (l.) — *Stizostedion volgense*

## Annelida

## Hirudinea

## PISCICOLIDAE

*Piscicola geometra* (Linnaeus, 1761) — *Abramis brama*

## Mollusca

## Bivalvia

## UNIONIDAE

*Anodonta* sp. (l.) — *Stizostedion lucioperca*, *Stizostedion volgense*, *Pelecus cultratus*

## Arthropoda

## Crustacea

## ERGASILIDAE

*Ergasilus sieboldi* Nordmann, 1832 — *Stizostedion lucioperca*, *Stizostedion volgense*, *Abramis brama*, *Carassius auratus gibelio*, *Silurus glanis*, *Pelecus cultratus*, *Cyprinus carpio*, *Ctenopharyngodon idella*, *Tinca tinca*

*Ergasilus gibbus* Nordmann, 1832 — *Anguilla anguilla*

## LERNAEOPODIDAE

*Achtheres percarum* Nordmann, 1832 — *Stizostedion lucioperca*, *Stizostedion volgense*

*Tracheliastes maculatus* Kollar, 1836 — *Abramis brama*

## ARGULIDAE

*Argulus foliaceus* (Linnaeus, 1758) — *Stizostedion lucioperca*, *Tinca tinca*

In the pike-perch (Table 1), a gut-parasitic trematode, *Rhipidocotyle illense* proved to be the commonest parasite: its metacercariae were also found on pike-perch. (Members of the genera *Rhipidocotyle* and *Bucephalus* differ only in the fimbria located at the cephalic end. At the same time, the cephalic fimbria of *B. polymorphus* are often drawn in; therefore, the data presented in the table not necessarily reflect the real incidence ratio of the two species). The nematode *Camallanus truncatus*, found in the gut and in the pyloric appendices, also proved to be a common pike-perch parasite.

Of the protozoan parasites, *Trichodina* spp. identified only to genera found on the gills occur much more frequently than suggested by the data shown in the table; namely, these ectoparasites disappear soon after placing the fish into an aquarium.

The cysts of *Henneguya creplini* could be detected on the gills in practically all seasons; however, spores developed in them only in the early spring period.

The renal tubules of pike-perch dissected in the spawning period often contained spores of *Sphaerospora damubialis*.

Of the pathogenic parasite species, mention should be made of the "teracotyle" metacercariae of the *Ichthyocotylurus* species parasitic in birds. These metacercariae were located in the abdominal organs and the peripharyngeal tissues, but in the majority of cases they also occurred as a mass attached to the pericardium, moving together and identical in size with the heart.

The gill-parasitic helminth *Ancyrocephalus paradoxus* was consistently found to possess demonstrable pathogenicity. Groups of this monogenean colonised the filaments at the convolutions of the gill arch; at these places the filaments broke and came off in fragments.

*Ergasilus sieboldi* infection also gave rise to gill lesions well visible with the unaided eye. That parasite established itself in large masses on the gill filaments and also on the external surface of the operculum.



The parasite fauna of the Volga pike-perch (Table 2) is practically identical with that of the pike-perch. It was interesting to note that in this fish species the individuals of *E. sieboldi* could only be found, in lower numbers, on the operculum. *Achtheres percarum*, which commonly occurred on the pike-perch, could not be demonstrated on the Volga pike-perch.

As regards the protozoan fauna, the *Goussia* species causing nodular coccidiosis and revealed by an early spring examination should be mentioned.

Only aimed studies concentrating on a few species were carried out on the parasite fauna of the eel (Table 3). First of all the infection and swimbladder lesions caused by *Anguillicola crassus* were monitored; however, we consistently looked for the occurrence of two fin parasites, *Myxobolus portucalensis* and *Daniconema anguillae* as well.

The commonest parasites of the bream (Table 4) included *Myxobolus* species and *E. sieboldi* specimens on the gills, the imago stages of *Asymphylogaster immitans* in the gut and the metacercaria stages of *Apophallus muehlingi* in the fins. In the May to mid-June period female specimens of *Tracheliastes maculatus* were found on the skin of all breams examined. The species indicated in the table as *Myxobolus* sp. I, II and III seem to represent separate species differing in location and morphology. In all probability, one of them found on the scales is a hitherto undescribed new parasite. In all but two cases, the developing female specimens of *Ph. ovata* were detected from breams infected with *Ligula intestinalis* plerocercoids. At the same time, the so-called "retarded", non-developing specimens of *Ph. ovata* were found in the swimbladder of all breams examined. The data shown in the tables indicate lower-than-actual prevalence values, as not all fish were dissected in physiological saline, which procedure is a precondition of reliable detection.

Only large sized, several years old specimens of gibel carp could be obtained from the fishermen. These fish were found to have a surprisingly low degree of parasitic infection (Table 5). At the same time, two protozoans (*Hoferellus carassii* and *Goussia carPELLI*) proved to be very common parasites.

As a fish species that has recently migrated into Lake Balaton, the river goby is infected by few parasite species (Table 6). No specific parasite was detected among the species found. At the same time, the river goby showed a conspicuously intensive infection with 3rd stage larvae of the eel parasite *A. crassus*.

As regards the parasitic infections of other fish species (Table 7), the low-intensity infection of the common carp and the extremely rare occurrence of parasite-free individuals should be mentioned.

The intensity of infection of other cyprinid species corresponds to that observed in the bream.

In the sheatfish fry and the ruffe (Table 6), infection with 3rd stage larvae of *A. crassus* was a conspicuous finding. In the sheatfish this infection even caused mortality due to ascites.

## DISCUSSION

Studies on the parasite fauna and seasonal occurrence of fish species living in a given habitat require extremely lengthy and consistent work. Studies of such type have first of all been carried out by specialists from the former Soviet Union. Of them, Shulman and Chernisheva (1969) studied the parasite fauna of fish in Lake Selinger, Allamuratov (1974) in the watershed area of the Surchandarya, while Pugachev (1984) studied it in fish derived from some rivers of North-east Asia. Data on the parasite fauna of fish in different reaches



Table 1  
Parasitic infections of *Sizostedion lucioperca* in Lake Balaton in 1994

Number of fish examined Body length (cm) Sampling time Sampling site Parasite recorded	Location	Spring		Summer			Autumn		
		1 16 Apr Szemes	7 15-50 Jun Tihany	10 5-40 Jun Keszthely	5 5-20 Jul Csopak	4 20-42 Aug Keszthely	4 33-51 Sep Keszthely	13 12-33 Oct Keszthely	11 30-51 Nov Alsóórs
<i>Ichthyophthirius multifiliis</i>	fins, gills	-	-	2/*	-	-	-	-	1/*
<i>Trichodinella</i> sp.	gills	-	-	6/(***-****)	-	-	-	-	-
<i>Trichodina</i> spp.	fins, gills	1/**	2/(***-**)	4/(***-**)	1/****	-	-	1/*	-
<i>Capriniana piscium</i>	gills	-	-	-	-	-	-	1/****	-
<i>Apiosoma</i> sp.	gills	1/**	-	-	-	-	-	-	-
<i>Sphaerospora danubialis</i>	kidney	1/****	-	-	-	-	-	-	-
<i>Henneguya creplini</i>	gills	-	3/(***-****)	7/(***-****)	-	2/**	1/*	1/**	5/(***-****)
<i>Myxobolus</i> sp.	kidneys	-	1/*	-	-	1/*	-	-	-
<i>Dermocystidium percae</i>	fins	-	1/**	1/*	-	-	-	2/*	-
<i>Ancyrocephalus paradoxus</i>	gills, operc.	-	1/40	8/9 8(1-18)	-	1/4	-	6/2.2(1-7)	7/4.4(2-8)
<i>Gyrodactylus luctipercae</i>	fins	1/30	1/30	-	-	-	-	-	-
<i>Trienophorus nodulosus</i> (l.)	liver	-	1/1	-	-	-	-	-	-
<i>Proteocephalus percae</i>	gut	-	3/32(10-70)	2/25(20-30)	1/15	-	-	-	-
<i>Bucephalus polymorphus</i> (l.)	fins, gills	-	1/20	3/2.7(2-3)	-	-	-	-	-
<i>Bucephalus polymorphus</i>	gut	1/3	2/24	5/4.4(2-8)	-	-	1/25	5/8.8(3-21)	3/5.3(4-6)
<i>Rhipidocotyle illense</i> (l.)	fins	-	-	1/1	-	-	-	1/1	1/1
<i>Rhipidocotyle illense</i>	gut	1/10	5/58	7/69(1-300)	-	5/43(30-50)	2/51(42-60)	13/19.5(4-48)	9/14.1(4-20)
<i>Nicola skrjabini</i>	gut	-	1/6	-	1/15	4/17(5-22)	-	-	3/7.3(2-14)
<i>Diplostomum spathaceum</i> (l.)	eye lenses	-	-	-	-	-	1/12	-	-
<i>Ichthyocotylurus</i> spp. (l.)	abd. cavity, heart	1/6	3/9.3(6-30)	5/16.4(6-25)	2/5(2-8)	1/8	2/2.5(2-3)	10/13.1(1-30)	8/62.9(20-118)
<i>Apophallus muehlingi</i> (l.)	fins	1/*	-	3/(***-****)	-	1/*	-	-	1/*
<i>Camallanus truncatus</i>	gut	1/20	4/15.8(3-20)	2/2(2)	1/15	3/2.7(2-4)	2/5(2-8)	10/9.1(4-22)	10/24.9(14-42)
<i>Ergasilus sieboldi</i>	gills, operc.	-	6/48(10-100)	5/63.6(22-99)	-	3/24(1-70)	1/6	11/28.2(1-50)	10/54.4(28-100)
<i>Argulus foliaceus</i>	fins	-	1/1	3/1.7(1-3)	-	2/1(1)	-	-	1/1
<i>Achtheres percarum</i>	gills	-	6/13.7(8-30)	6/7.8(5-10)	-	3/3(1-6)	-	3/2.3(1-4)	10/5.7(1-16)
<i>Anodonta</i> sp. (l.)	gills, fins	-	-	4/5.5(2-8)	-	1/1	-	-	-

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

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Table 2  
Parasitic infections of *Sizostedion volgense* in Lake Balaton in 1994

Number of fish examined Body length (cm) Sampling time Sampling site Parasite recorded	Location	Spring		Summer		Autumn	
		6 14-21 Apr Szemes	3 23-28 May Szemes	3 13-16 Aug Keszthely	11 14-29 Sep Keszthely	5 14-27 Oct Keszthely	2 29-30 Nov Alsóórs
<i>Goussia</i> sp. I	gut	-	-	-	1/**	-	-
<i>Goussia</i> sp. II	gut	2/(***-*)	-	-	-	-	-
<i>Sphaerospora damubialis</i>	kidney	2/(***-*)	-	-	2/*	-	-
<i>Myxobolus</i> spp.	gut, kidney	2/*	-	-	-	-	-
<i>Ancyrocephalus paradoxus</i>	gills, operc.	6/6.2(2-15)	1/40	8/9.8(1-18)	-	1/4	-
<i>Gyrodactylus luciopercae</i>	fins	2/5(1-10)	1/4	-	-	-	-
<i>Proteocephalus percae</i>	rectum	-	-	1/12	-	-	-
<i>Bucephalus polymorphus</i>	gut	2/10(10)	1/10	-	3/6.3(3-10)	-	-
<i>Rhipidocotyle illense</i>	gut	4/23.8(5-40)	2/22(14-30)	3/31.7(15-40)	5/29.4(11-70)	4/17.5(7-39)	1/16
<i>Nicola skrjabini</i>	gut	1/20	-	2/11.5(3-20)	4/1.8(1-2)	1/3	-
<i>Ichthyocotylurus</i> spp. (l.)	body cavity	4/9(4-20)	1/30	2/11.5(8-15)	11/40.1(8-100)	2/24.5(18-31)	2/39(35-43)
<i>Tylodelphis clavata</i>	eye lens	-	1/2	-	-	-	-
<i>Raphidascaris acus</i> (l.)	gut wall	-	-	1/1	-	-	-
<i>Camallanus truncatus</i>	gut wall	5/23.2(4-50)	3/12.7(3-20)	2/8(8)	11/8.8(2-20)	4/5.5(3-8)	2/46(45-47)
<i>Anguillicola crassus</i> (l.)	gut wall	-	-	2/19(16-22)	1/35	-	-
<i>Ergasilus sieboldi</i>	gills	-	-	1/10	-	-	2/31(18-44)
<i>Anodonta</i> sp. (l.)	gills, fins	3/2.3(2-3)	-	2/2.5(2-3)	-	-	-

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections



Table 4  
Parasitic infections of *Abramis brama* in Lake Balaton in 1994

Number of fish examined Body length (cm) Sampling time Sampling site	Parasite recorded	Location	Spring			Summer			Autumn		
			18 Apr Szemes	7 May Szemes	4 Jun Tihany	4 Jun Keszthely	4 Jul Csopak	3 Aug Keszthely	5 Sep Keszthely	3 Oct Keszthely	12 Nov Alsóórs
	<i>Trypanosoma danilewskyi</i>	blood	2/*	-	-	-	-	-	-	-	-
	<i>Eimeria rutilii</i>	gut	-	-	-	1/*	-	-	-	-	-
	<i>Goussia stankovitchi</i>	gut	-	-	-	1/*	1/*	-	-	-	-
	<i>Goussia pannonica</i>	gut	1/*	-	-	-	-	-	-	-	-
	<i>Goussia leucisci</i>	kidney	1/***	-	-	-	-	-	-	-	-
	<i>Chloromyxum</i> sp.	gall bl.	3/*-***	-	-	-	-	-	-	-	2/*
	<i>Sphaerospora</i> sp.	kidney	1/*	-	-	-	-	-	-	-	-
	<i>Myxidium rhodei</i>	kidney	-	-	1/**	-	2/*-***	-	-	-	-
	<i>Myxidium</i> sp.	gall bl.	1/**	1/***	-	-	-	-	-	-	1/**
	<i>Myxobolus legeri</i>	ureter	3/*-**	-	-	-	-	-	-	-	-
	<i>Myxobolus bramae</i>	gills	11/*-***	4/*-**	-	2/*-**	3/*-***	1/***	-	-	2/*
	<i>Myxobolus</i> sp. (I)	gills	4/*	-	-	-	-	-	-	-	-
	<i>Myxobolus</i> sp. (II)	scales	6/*-***	3/*	-	-	2/*	1/***	-	-	-
	<i>Myxobolus</i> sp. (III)	gut	1/**	-	-	1/*	-	-	-	-	1/*
	<i>Myxobolus pseudodispar</i>	kidney	1/*	1/*	-	-	1/*	-	-	-	-
	<i>Ichthyophthirius multifiliis</i>	gills	-	2/*	-	-	-	-	-	-	-
	<i>Dactylogyrus auriculatus</i>	gills	-	-	-	-	1/20	-	-	1/57	-
	<i>Dactylogyrus falcatus</i>	gills	-	5/13.6(8-20)	1/10	1/8	2/22.5(15-30)	2/5.5(4-7)	-	-	1/6
	<i>Dactylogyrus wuelleri</i>	gills	-	-	-	-	1/10	-	-	1/22	-

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 4  
Parasitic infections of *Abramis brama* in Lake Balaton in 1994 (continued)

Number of fish examined Body length (cm) Sampling time Sampling site Parasite recorded	Location	Spring			Summer			Autumn		
		18 14-40 Apr Szemes	7 19-30 May Szemes	4 22-28 Jun Tihany	4 10-30 Jun Keszthely	4 12-32 Jul Csopak	3 27-30 Aug Keszthely	5 26-33 Sep Keszthely	3 26-28 Oct Keszthely	12 20-30 Nov Alsóörs
<i>Dactylogyrus zandii</i>	gills	-	-	-	2/13(6-20)	-	-	-	1/20	-
<i>Diplozoon paradoxum</i>	gills	-	2/6(2-10)	-	-	2/2.5(1-4)	1/4	-	-	1/1
<i>Caryophyllaeus laticeps</i>	gut	-	1/6	-	-	-	-	-	-	-
<i>Ligula intestinalis</i> (l.)	abd. cav.	3/1.3(1-2)	-	-	-	-	-	-	-	-
<i>Paradilepis scolecina</i> (l.)	abd. cav.	2/5(2-8)	-	-	1/2	1/8	3/26.7(20-30)	1/15	1/30	2/10.5(1-20)
<i>Bucephalus polymorphus</i> (l.)	gills	-	-	-	-	-	-	1/5	-	-
<i>Rhipidocotyle illense</i> (l.)	fins	-	-	1/4	3/13.7(1-20)	1/15	2/8.5(8-9)	-	-	-
<i>Sanguinicola</i> sp. (l.)	kidney	2/*	-	1/*	-	-	1/*	-	3/*	2/*
<i>Asymphylostoma immitans</i>	gut	8/22.5(10-40)	5/34.4(5-100)	2/19(8-30)	3/23.3(5-45)	2/11.5(2-21)	-	-	-	1/8
<i>Apophallus muehlingi</i> (l.)	fins	7/*-***	3/*-***	-	4/*-***	3/*-***	2/*	5/*	-	5/*-***
<i>Diplostomum spathaceum</i> (l.)	eye lenses	2/5.5(4-7)	-	-	-	2/14(8-20)	-	-	1/2	-
<i>Ichthyocotylurus</i> spp. (l.)	abd. cav.	3/12.3(10-15)	1/1	-	-	-	1/20	-	1/1	-
<i>Philometra ovata retard</i>	swimbl.	5/2.2(1-4)	4/2(1-3)	2/1.5(1-2)	1/2	2/8.5(2-15)	3/14.7(4-30)	1/4	3/14(8-24)	11/5(2-10)
<i>Philometra ovata</i>	abd. cav.	4/14(1-40)	-	-	1/1	1/1	-	-	-	-
<i>Contracoecum</i> sp. (l.)	int. wall	-	-	-	-	-	1/1	1/15	1/1	1/1
<i>Piscicola geometra</i>	scale, mouth	-	1/6	-	-	-	-	-	-	-
<i>Ergasilus sieboldi</i>	gills	10/7.7(2-10)	-	1/5	-	-	-	-	-	8/7.8(3-20)
<i>Tracheliastes maculatus</i>	scales	-	7/21.9(14-36)	4/21(10-38)	3/15(2-40)	-	-	-	-	-

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 5  
Parasitic infections of *Carassius auratus gibelio* in Lake Balaton in 1994

Parasite recorded	Location	Spring				Summer				Autumn			
		2	1	4	2	1	2	4	1	2	4	1	4
Number of fish examined		15-30	25	29-40	28-30	30	27-32	27-34					
Body length (cm)		Apr	Jun	Jun	Jul	Aug	Sep	Oct					
Sampling time		Szemes	Tihany	Keszthely	Tihany	Keszthely							
Sampling site													
<i>Spironucleus elegans</i>	gut	-	-	-	-	-	-	-	-	-	-	-	1/**
<i>Goussia carpelli</i>	gut	-	1/**	2/*_**	-	1/***	-	4/*_***	4/**	-	-	-	4/**
<i>Goussia leucisci</i>	kidney	-	-	-	-	-	-	1/*	-	-	-	-	-
<i>Hoferellus carassii</i>	kidney, ureter	2/***	1/***	2/***	2/***	1/***	-	4/*_***	4/*_***	-	-	-	4/*_***
<i>Paradilepis scolastica</i> (l.)	abdominal cavity	-	-	-	-	-	-	-	1/1	-	-	-	-
<i>Sanguinicola inermis</i>	kidney	-	-	1/1	-	-	-	-	-	-	-	-	-
<i>Apophallus muehlingi</i> (l.)	fins	-	1/20	-	-	-	-	-	-	-	-	-	-
<i>Diplostomum spathaceum</i> (l.)	eye lenses	-	-	-	-	-	-	-	-	-	-	-	-
<i>Philometroides sanguinea</i>	fins	1/2	-	-	-	-	-	-	1/1	-	-	-	-
<i>Ergasilus sieboldi</i>	gills	1/4	1/6	1/2	1/1	-	-	-	-	-	-	-	-

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 6  
Parasitic infections of *Silurus glanis*, *Gymnocephalus cernuus* and *Neogobius fluviatilis* in Lake Balaton in 1994

Number of fish examined body length (cm) sampling time sampling site Parasite recorded	Location	Silurus glanis		Gymnocephalus cernuus		Neogobius fluviatilis	
		Summer 2 34-36 Aug	Autumn 2 24-34 Sep	Spring 4 8-10 Apr	Spring 9 7-12 Apr	Summer 11 5-11 Jul	Summer 7 4-7 Aug Sóstó
<i>Goussia acerinae</i>	gut	-	-	1/*	-	-	-
<i>Goussia</i> sp.	gut	-	-	-	1/*	-	-
<i>Aptosoma</i> sp.	fins	-	-	1/**	-	-	-
<i>Dactylogyrus amphibothrium</i>	gills	-	-	2/12.5(5-20)	-	-	-
<i>Dactylogyrus hemiamphibothrium</i>	gills	-	-	1/10.	-	-	-
<i>Gyrodactylus</i> sp. I.	fins	-	-	2/45(40-50)	-	-	-
<i>Gyrodactylus</i> sp. II.	fins	-	-	-	1/4	-	-
<i>Proteocephalus osculatus</i>	gut	2/15(8-22)	2/19(8-30)	-	-	-	-
<i>Proteocephalus cernuae</i>	gut	-	-	1/3	-	-	-
<i>Proteocephalus</i> sp.	gut	-	-	-	-	1/2	-
<i>Ligula</i> sp.	abd. cav.	-	-	-	-	3/1	-
<i>Nicola skrjabini</i>	gut	-	-	4/10.5(8-15)	-	-	-
<i>Orientocreadium siluri</i>	gut	1/9	-	-	-	-	-
<i>Diplostomum spathaceum</i> (l.)	eye lenses	-	1/19	-	-	-	-
<i>Ichthyocotylurus</i> sp. (l.)	abd. cav.	-	-	-	-	-	-
<i>Camallanus truncatus</i>	gut	-	-	4/8.5(2-17)	-	-	-
<i>Anguillicola crassus</i> (l.)	intestinal wall	1/27	2/170(40-300)	3/4.3(1-8)	1/1	8/3.1(2-6)	-
<i>Ergasilus sieboldi</i>	gills	2/4(2-6)	1/2	4/56.8(40-72)	6/14.8(1-40)	11/4.1(1-10)	6/18.8(4-58)

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections





of the River Danube can be found in works of Roman (1955) and Vojtek (1959), while those for the River Tisza have been reported by Edelényi (1967) and Ergens et al. (1975).

The results of this study indicate that the parasite fauna of fishes of the Palaearctic region is rather uniform. The fact that in Lake Balaton we could not detect numerous parasites recorded from other places, reflects differences between the intermediate host organisms living in the different habitats, rather than actual differences between regions.

This work involved a larger sample of fish of the greatest economic and biological importance. Therefore, the data obtained on such species enable a more reliable evaluation of the parasite fauna than do the dissection data of fish of which a smaller sample was examined. However, the interpretation of even the former data requires some caution. The presence of endoparasitic helminths is always a reliable indicator of the degree of infection. At the other side, data concerning protozoans, crustaceans and monogeneans freely moving on the skin and gills must be evaluated critically. Namely, in laboratory the number of these organisms usually decreased if the fish were kept in flow-through water, while in aerated aquaria it increased.

The parasites found generally correspond to those demonstrated by Molnár (1962, 1964, 1966a, 1966b, 1968, 1969, 1970a, 1970b), Matskási (1967, 1968), Matskási et al. (1971) and Mészáros (1967, 1968). However, the data obtained on the protozoan fauna so far indicate that the occurrence of several species hitherto not described or not detected in Lake Balaton should be reckoned with.

The results of this study suggest that in some respects the parasite fauna of Lake Balaton fishes is characterized by stability, which is reflected in the continuing presence of species that were demonstrated decades ago. On the other hand, the changes occurring in the life of the lake, such as the immigration or introduction of new fish species, have led to the appearance and, in some cases, mass multiplication of new parasites.

Of parasites which are outstanding because of their permanent presence, the commonest species is *E. sieboldi* which establishes itself on the gills and even on the operculum of the pike-perch. That parasite had already been described by Geyer (1939a). It was also Geyer (1939b) who reported the periodic occurrence of, and the skin lesions caused by *Tracheliastes maculatus* on bream. Already Jaczó (1940) pointed out the high prevalence of *Myxobolus* spp. living on the gills of the bream, although the spores found by us could not yet be identified with the species *M. hungaricus* and *M. variabilis* described by him. From *Perca fluviatilis*, Jaczó (1940) also detected *Henneguya* cysts which probably belonged to the species recorded by us from pike-perch as *H. creplini*. Molnár (1966a) mentions it as a characteristic feature of the Lake Balaton bream that the female specimens of *Ph. ovata* can reach their full maturity only in fish infected by the plerocercoid of *Ligula intestinalis*, while in other fish they remain in a stunted, "retarded" state. In the majority of cases, this rule applied also in the present studies; however, the two cases when larva-containing females were found also in breams not infected by *Ligula* suggest that completion of the cycle is possible also in *Ligula*-free fish.

In the pike-perch and Volga pike-perch the most typical finding was the mass of *Ichthyocotylurus metacercariae* which established themselves in the abdominal cavity, primarily on the surface of the heart. This is obviously related to the increase of the bird population in the Lake Balaton region.

As regards the new parasites demonstrated from Lake Balaton, the most important findings were the mass occurrence and pathogenicity of *A. crassus* in eel (Molnár et al. 1991, 1993, 1994, Székely et al. 1991) and the high prevalence of its paratenic larvae in other fish species (Székely 1994, 1995). At the same time, it was surprising to see that the

*Pseudodactylogyrus* species common in intensive eel farms cause only moderate infection in Lake Balaton eels.

The species *Hoferellus carassii*, *Spironucleus elegans* and *Paradilepis scolecina*, *Orientocreadium siluri* are now reported from Lake Balaton for the first time, even though their appearance there could be expected. In addition, it is probable that among the parasites now designated as *Goussia* sp. and *Myxobolus* sp. new, hitherto not described species could be distinguished by more thorough studies.

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#### Molnár, K. és Székely, Cs.: A Balaton néhány fontosabb halfajának parazitológiai vizsgálata

A szerzők a Balaton gazdaságilag és faunisztikailag legfontosabb 15 halfaja 299 egyedének parazitás fertőzöttségét követték nyomon. Egy éves vizsgálat keretében 71 parazita teljes faji, 17 parazita genusig történő meghatározását végezték el, s adtak azokra nézve adatokat. A fajilag azonosított 23 egysejtű élősködőből legnagyobb fajszámmal a Myxosporea osztály tagjai (10) kerültek kimutatásra. A Coccidia osztályt 8 faj, az Oligohymenophorea, Kinetophragminophorea, Kinetoplastidea, Diplomonadea osztályokat 1-1 faj képviselte. Ugyancsak kimutatásra került a bizonytalan rendszertani helyű *Dermocystidium percae* faj is. A metazoonok közül a Monogenea 13, a Cestoda 11, az Aspidogastrea 1, a Trematoda 10, a Nematoda 7, a Hirudinea 1, a Crustacea osztályok 5 faja került kimutatásra. A Balatonban a leggyakoribb parazitának a behurcolt angolnaélősködő, az *Anguillicola crassus* tekinthető, mely a végleges gazdán kívül több halfajból, mint paratenikus gazdából kimutatható volt. Esetenként jelentős *Ergasilus sieboldi*-fertőzöttség alakult ki süllőn, amelynek a kopoltyúján kívül a kopoltyúfedőit is nagy tömegben lepték el ezek a rákok. Kórtani szempontból jelentősnek látszanak a süllő szivbúrához tapadó *Ichthyocotylurus*-metacerkáriák, illetve a dévér testfelületén a tavaszi hónapokban megtelepedő *Tracheliastes maculatus* egyedei. A talált élősködők közül a *Hoferellus carassii*, *Spironucleus elegans*, *Paradilepis scolecina* és *Orientocreadium siluri* első ízben kerülnek kimutatásra a Balatonból.

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